(12) UK Patent Application (19) GB (11) 2 110 834 A

(21) Application No 8136176
(22) Date of filing 1 Dec 1981
(43) Application published
22 Jun 1983
(51) INT CL³
G02B 5/14
(52) Domestic classification
G2J GEA
(56) Documents cited
None
(58) Field of search
G2J
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(54) Connectors for optical fibres

(57) A two component connector (1, 2) for optical fibres (10, 23) comprises a linear bearing assembly (36) provided in one of the components (2) for movably supporting elements (7, 20) provided by the component, respectively, when the two components are engaged or disengaged. The linear bearing assembly has spherical units or balls (30) projecting radially inwardly beyond the neighbouring cylindrical surface of the bearing assembly, the units or balls being angularly spaced around the longitudinal axis of the linear bearing assembly and allowing longitudinal movement of element 7.

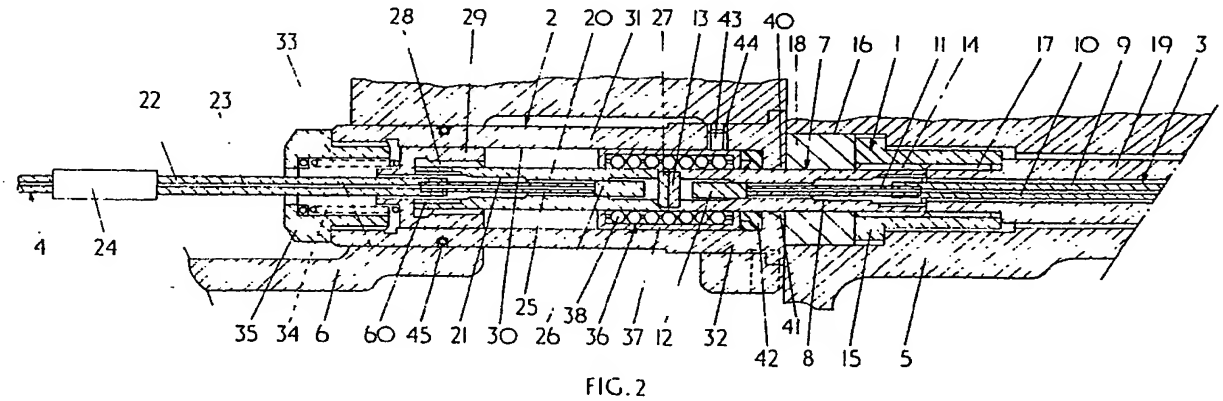

FIG. 2

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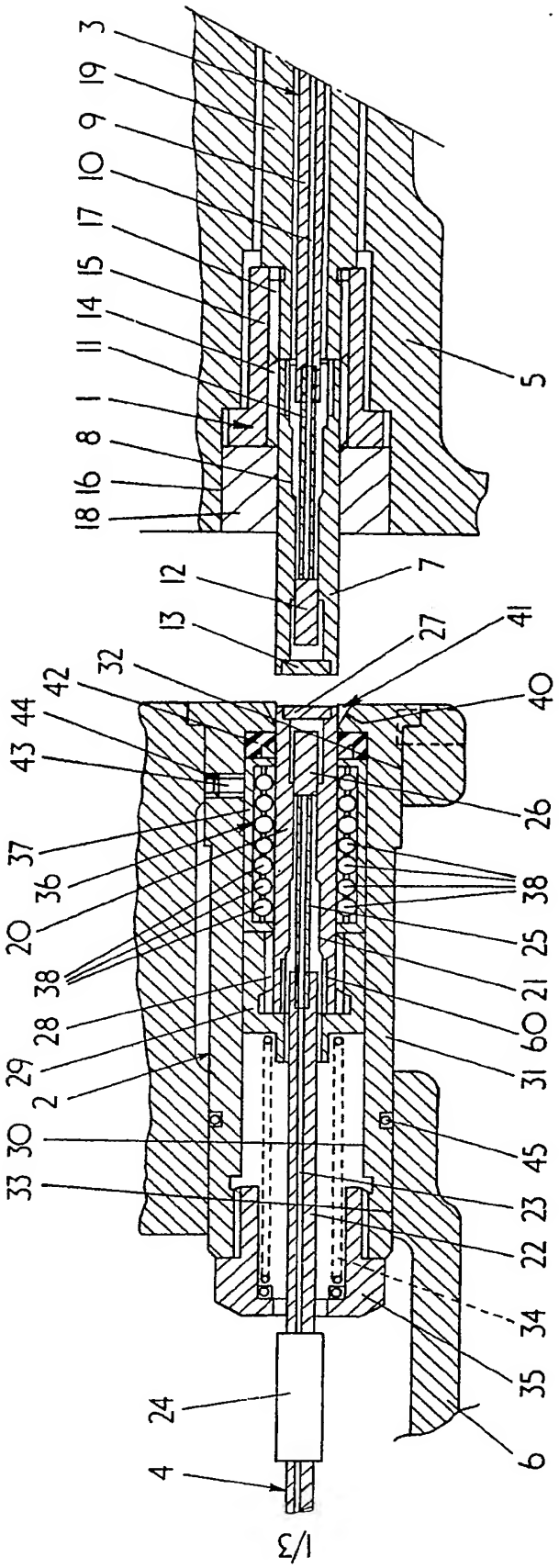

FIG.1

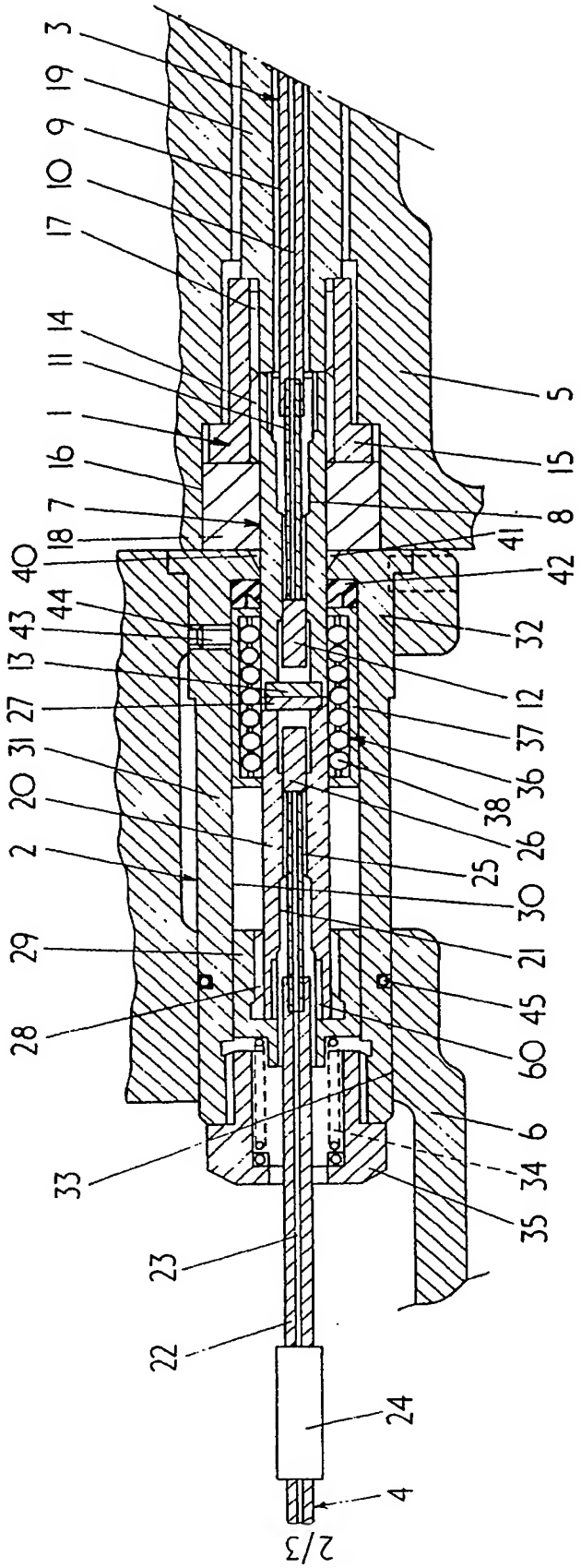

FIG.2

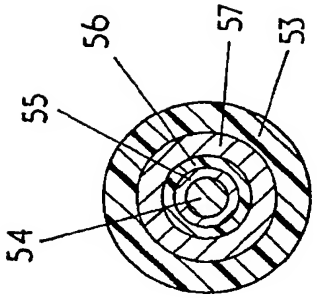

FIG. 4

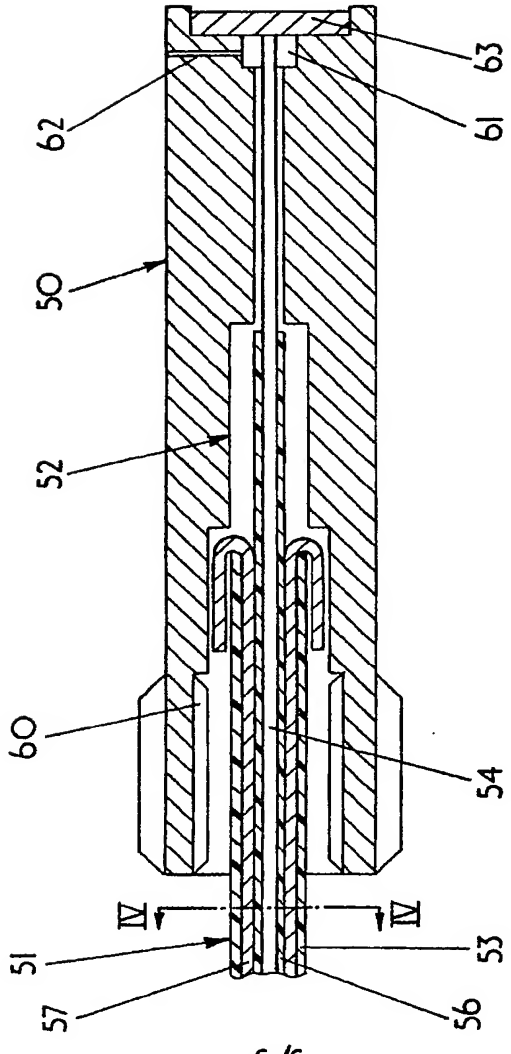

FIG. 3

SPECIFICATION

Connectors for optical fibres

This invention relates to connectors for optical fibres.

In particular, the present invention relates to a connector comprising two components which are capable of being engaged to effectively make an optical fibre connection and disengaged to break the connection.

It is an object of the present invention to provide a connector for optical fibres which tends to be suitable for use in dirty, dusty or muddy conditions where fine particles of solid material or slurry tend to infiltrate the connector during the time the two components are being engaged or disengaged.

According to the present invention a connector for optical fibres comprises two components attachable to end margins of two optical fibres, respectively, and capable of being engaged to effectively make an optical fibre connection and disengaged to break the connection, one of the components comprising a pin element associated with the end margin of one of the two optical fibres and the other of the components comprising a mechanism for receiving the pin element to effectively connect the two optical fibres when the two components are engaged, the mechanism comprising a movably mounted elongated element associated with the end margin of the other of the two optical fibres and a bearing assembly for movably contacting the elongated element for longitudinal movement, the bearing assembly comprising a plurality of bearing units angularly spaced around the longitudinal axis of the elongated element with each unit being arranged to facilitate longitudinal movement of the elongate element with each unit being mounted for movement in the general direction of the longitudinal axis and/or being rotatable about an axis substantially normal to the longitudinal axis, in use during engagement of the two components which the pin element is received by the mechanism, the elongated element is urged to move along the bearing assembly by abutment with the pin element.

Preferably, the bearing assembly comprises a plurality of sets of bearing units mounted in a bearing casing.

Preferably, each set of bearing units is mounted in a face arranged to run in the general direction of the longitudinal axis of the elongate element.

Alternatively, each set of bearing units is mounted in a generally cylindrical bearing casing.

Conveniently, the bearing assembly is mounted in a main generally cylindrical bearing housing.

Advantageously, the or at least some of the bearing units are substantially spherical and support for universal rotation.

Preferably, the elongated element is resiliently biassed towards a disengaged mode.

Advantageously, the bearing assembly and the elongated element are mounted in a housing.

Preferably, a seal is provided around the elongated element.

Preferably, the bearing assembly is fixedly mounted in the housing.

Conveniently, the pin element and the elongated element are generally circular in cross-section.

By way of example only, one embodiment of the present invention now will be described with reference to the accompanying drawings, in which:-

Figure 1 shows a longitudinal sectional view of a two component connector for optical fibres, the two components being shown in a disengaged disconnected mode;

Figure 2 shows a similar longitudinal sectional view to Figure 1 but with the two components shown in an engaged connected mode;

Figure 3 shows a longitudinal sectional view through a modified detail of Figure 1; and

Figure 4 shows a cross-sectional view through line IV-IV of Figure 3, Figure 4 being drawn on a larger scale.

Figures 1 and 2 of the drawings show the optical fibre connector to comprise two components 1 and 2 attachable to the end margins of two optical fibre cables 3 and 4, respectively. The connector forms part of an electrical plug and socket connector 5, 6 only adjacent portions of the housing of which are shown.

The component 1 comprises a generally cylindrical, projecting pin element 7 having a generally cross-sectioned body and being provided with a stepped axially extending bore 8 for receiving the end of the associated optical fibre cable 3 which comprises an outer protection sheath 9 and an inner optical fibre 10 (which is not shown in section). Adjacent to the end of the cable the outer sheath 9 is removed and a ferrule 11 is provided around the optical fibre, the ferrule being retained in position by being a forced fit under the adjacent end portion of the outer sheath. All voids between the outer sheath and the adjacent portion of the element body are filled with epoxy resin. A thread arrangement 60 is provided to key with the resin. The end of the optical fibre abuts a generally cylindrical lens arrangement 12 arranged to expand the cross sectional area of the optical path towards a window 13 fixedly located in a recess defined in the end of the body of the pin element 7. In other arrangements the optical fibre need not abut the lens arrangement provided that the optical path is brought to the focus of the lens arrangement.

The pin element 7 has a threaded portion 14 for retaining the element to an adaptor 15 which in turn is fixedly located in a stepped bore 16 provided in the housing 5. A bush 18 of resilient plastics material closes the bore 16 and a gland 19 surrounds the cable 3 within the housing and beyond the pin element 7. The adaptor 15 is fixed to the bush 18 by adhesive and to the gland 19 by a thread 17. The gland 19 is retained to the connector housing 5 by a retaining peg (not shown) engaging in a recess in the gland.

The component 2 comprises a mechanism for receiving the pin element 7 when the two components are in an engaged connected position as indicated in Figure 2. The mechanism comprises a movably mounted, generally cylindrical elongated element 20 which is identical to the element 7 and

which has a generally circular cross-sectioned body and provided with a stepped axially extending bore 21 for receiving the end of the associated optical fibre cable 4 which comprises an outer protective sheath 22 and an optical fibre 23 (which is not shown in section). A joint box 24 for fixedly joining two lengths of the cable 4 is shown in the Figures (the joint box is not shown in section). Adjacent the end of the cable the outer sheath 22 is removed and a ferrule 25 is provided around the optical fibre, the ferrule being retained in position by being a forced fit under the adjacent end portion of the outer sheath. All voids between the outer sheath and the adjacent portion of the element body are filled with epoxy resin. A thread arrangement 60 is provided to key with the resin and also: In another arrangement joint box 24 may be rigidly attached to pin element 20 by a tube fitted over the fibre sheath 22 and screwed into thread 60. The end of the optical fibre abuts a generally cylindrical lens arrangement 26 arranged to expand the cross-sectional area of the optical path towards a window 27 fixedly located in a recess defined in the end of the body of the elongated element 20. As with the aforementioned pin element 7, in other embodiments the optical fibre need not abut the lens arrangement provided that the optical path is brought to the focus of the lens arrangement.

The elongated element 20 has a threaded portion 28 for retaining the element to an adaptor 29 which is slidably mounted within a generally cylindrical bore 30 defined by a tubular housing 31 secured in bores 32 and 33 formed in the aforementioned main housing 6. The adaptor 29 is resiliently biassed under the action of a coil spring 34 mounted between the adaptor 29 and an end cap 35 for the tubular housing 31.

The elongated element 20 is movably supported for longitudinal motion in a linear bearing assembly 36 comprising a casing 37 and four sets of generally spherical bearing units or balls 38 which project radially inwards beyond the bearing casing to engage the radially outer surface of the elongate element. The four sets of balls are angularly spaced around the longitudinal axis of the generally cylindrical elongated element 20 to support the elongated element. The balls in each set are arranged to facilitate longitudinal movement of the elongate element with the units in each set being slidably mounted for movement in the general direction of the longitudinal axis. Each set of bearing units is mounted in a race arranged to run in the general direction of the longitudinal axis of the elongate element. The return run of each set of bearing units is not shown in the drawings and lies within the bearing casing 36 remote from the bearing surface adjacent to the element. For convenience the four sets of bearing units are mounted in a main, generally cylindrical bearing housing.

In another construction, the bearing assembly comprises three sets of bearing units with the three sets angularly spaced around the longitudinal axis of the elongate element. Typically in a four set arrangement the sets are angularly spaced at substantially 90° and in a three set arrangement the sets are angularly spaced at substantially 120°.

The units or balls 38 are free for universal rotation including rotation about an axis substantially normal to the longitudinal axis of the element.

In other embodiments of the units or balls in each set are mounted in an annular casing arranged around the elongate element, the units or balls in each set being angularly spaced around the longitudinal axis of the elongate component and being arranged for universal station including rotation about an axis substantially normal to the longitudinal axis of the elongate element.

As previously stated each unit or ball 38 is permitted universal rotation including rotation about an axis normal to the longitudinal axis of the elongated element when looking in a direction along the longitudinal axis of the elongate element.

The end of the tubular housing 31 remote from the end cap 35 is provided with a lip 40 defining a generally circular opening 41 having an outwardly tapering mouth for receiving the end face of the pin element 7 when the two components are being engaged into a connected mode. A resilient annular lip seal 42 is provided adjacent to the lip 40 to slidably contact the element 20 or 7 (depending upon the operational mode of the connector) tending to prevent ingress of dirt into the component 2. The end faces of elements 7 and 20 deliberately are not chamfered, to prevent dirt passing under the seal.

The linear bearing assembly 36 is fixedly retained in the tubular housing 31 by a removable screw 43 provided in a threaded bore 44 in the tubular housing.

In the construction shown in Figures 1 and 2 of the drawings a ring seal 45 is provided in the portion of the tubular housing 31 accommodated within the aforementioned bore 33. In another arrangement resilient annular lip seal 42 may be an integral part of linear bearing assembly 36.

In use when it is desired to engage the two components to effectively connect the optical fibres 10 and 23 in co-axial relationship, the two disconnected components are arranged such that the projecting pin element 7 is aligned with the mouth opening 41 (as indicated in Figure 1). The two components are urged together then such that the end of the pin element 7 including the window 13 enters the mouth opening 41 and abuts the end of the elongated element 20 including the window 27. Further relative movement of the components causes the pin element to enter the opening 41 urging the elongated element 20 to move along the linear bearing assembly 36 against the action of the spring 34. During movement of the elements 7 and 20 relatively to the linear bearing assembly 36 each of the balls 38 moves along its associated bearing race and/or rotates or rolls about an axis normal to the longitudinal axis of the element to facilitate an easy connection. The engaging movement continues until the two components fully abut as indicated in Figure 2. The two components then are in the fully engaged connected mode with the two optical fibres 10 and 23 effectively connected in co-axial relationship for the transmission of optical

signals.

The lens arrangements 12 and 26 are provided to effectively increase the cross-sectional area of the optical path in the vicinity of the joint between the two elements 7 and 20 to accommodate a tolerable amount of axial misalignment and/or dirt existing between the two optical fibres.

The windows 13, 27 which are made of relatively hard material to resist scratching are arranged flush with the end face of the associated element 7, 20 to facilitate easy cleaning before the two components are engaged. The windows may be recessed by a very small depth to prevent them scratching each other during connection or disconnection.

Means (not shown) may be provided for releasably retaining the two components in an engaged connected mode.

As the balls 38 project radially inwards beyond the cylindrical surface presented by the linear bearing assembly the connector is able to cope with relatively fine particles of solid material or mud which find there way into the mechanism for accepting the pin element during the engaging operation. Thus, the connector according to the described embodiment of the present invention tends to be suitable for use in dirty or dusty environments, as for example, environments encountered in an underground mine.

Upon the two components being disengaged to effectively disconnect the optical fibres, the pin element 7 is withdrawn from engagement with the component 2 and the elongate component 20 is urged by the action of the spring 34 to move longitudinally in the linear bearing assembly 36 back into disconnected mode as indicated in Figure 1. The elongate element 20 co-operates with the seal 42 to effectively close the mouth 40.

Figures 3 and 4 show details of a modified element 50 for accommodating a large core optical fibre cable 51 in which no lens arrangement is provided. The element 50 may be a pin element and/or a elongate element.

The element 50 has a generally circular cross-sectioned body provided with a stepped axially extending bore 52 for receiving the end of the associated optical fibre cable which comprises an outer protection sheath 53 and an inner optical fibre core 54 of relatively large cross-sectional area, the silica core being provided with a silicone cladding 55. A secondary plastic cladding 56 is provided around the silicone cladding and a strengthing layer 57 is provided beneath the outer protection sheath 53.

As seen in the drawing the outer sheath 53 adjacent to the end of the fibre cable is removed and the strengthening layer is turned back to provide a secure fitting. All voids between the outer sheath and the adjacent portion of the element body are filled with epoxy resin. A thread arrangement 60 is provided to key with the resin.

The core of the optical fibre cable extends into narrow portions of the stepped bore which is precisely formed to provide accurate positioning of the core within the element. In narrow portions of the bore all the silicone cladding is removed from the core and replaced with a hard, low refractive index polymer. Adjacent to the end of the core the stepped bore 52 is enlarged to form a chamber 61 for containing an index matching compound which is injected into the chamber via a fine cross bore 62 using a hypodermic syringe.

A window 63 is provided in the end face of the element, the window being shown positioned slightly back from the end face to prevent scratching as previously discussed with reference to Figures 1 and 2. Alternatively, the window may be flush with the end face of the element body.

The end face of the core 54 is located as close to the window as possible. The end face is prepared optically flat prior to assembly.

The arrangement shown in Figures 3 and 4 has the advantage compared to the arrangement shown in Figures 1 and 2 in that no lens arrangement is required.

In other arrangements each of the cylindrical lens 12 or 26, is replaced with another form of converging lens, as for example, a spherical or rod lens.

CLAIMS

1. A connector for optical fibres comprising two components attachable to end margins of two optical fibres, respectively, and capable of being engaged to effectively make an optical fibre connection and disengaged to break the connection, one of the components comprising a pin element associated with the end margin of one of the two optical fibres and the other of the components comprising a mechanism for receiving the pin element to effectively connect the two optical fibres when the two components are engaged, the mechanism comprising a movably mounted elongated element associated with the end margin of the other of the two optical fibres and a bearing assembly for movably contacting the elongated element for longitudinal movement, the bearing assembly comprising a plurality of bearing units angularly spaced around the longitudinal axis of the elongated element with each unit being arranged to facilitate longitudinal movement of the elongate element with each unit being mounted for movement in the general direction of the longitudinal axis and/or being rotatable about an axis substantially normal to the longitudinal axis, in use during engagement of the two components which the pin element is received by the mechanism, the elongated element is urged to move along the bearing assembly by abutment with the pin element.

2. A connector as claimed in claim 1, in which the bearing assembly comprises a plurality of sets of bearing units mounted in a bearing casing.

3. A connector as claimed in claim 2, in which each set of bearing units is mounted in a race arranged to run in the general direction of the longitudinal axis of the elongate element.

4. A connector as claimed in claim 2, in which each set of bearing units is mounted in a generally cylindrical bearing assembly.

5. A connector as claimed in any one of the preceding claims, in which the bearing assembly is mounted in a main generally cylindrical bearing

housing.

6. A connector as claimed in any one of the preceding claims in which the or at least some of the bearing units are substantially spherical and support for universal rotation.

7. A connector as claimed in any one of the preceding claims, in which the elongated element is resiliently biassed towards a disengaged mode.

8. A connector as claimed in any one of the preceding claims, in which the bearing assembly and the elongated element are mounted in a housing.

9. A connector as claimed in claim 8, in which a seal is provided around the elongated element.

10. A connector as claimed in claim 8 or 9, in which the bearing assembly is fixedly mounted in the housing.

11. A connector as claimed in any one of the preceding claims, in which the pin element and the elongated element are generally circular in cross-section.

12. A connector for optical fibres substantially as described herein and substantially as shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.